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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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SCIENTIFIC WORTHIES.

XXXI.—ALBERT VON KÖLLIKER.

ALBERT VON KÖLLIKER was born at Zürich on July 6, 1817; he therefore is the eldest of the illustrious teachers who have brought down to the present day the tradition of that active spirit of biological inquiry which had its most complete expression, during the first part of the century, in the life and work of Johannes Müller.

After visiting several universities, and so hearing the lectures of many eminent biologists (among whom Johannes Müller himself may be specially mentioned), Kölliker took the degree of M.D. in Heidelberg in 1842; and in 1843 he commenced his teaching career as Prosector to Henle in Zürich. In 1846 he became Professor extraordinarius in Zürich, and in the autumn of 1847 he was called to Würzburg as Professor of Human Anatomy. This chair he has continuously occupied ever since. The remarkable Festschrift, recently published in his honour, contains a long list of names of men who are proud to call themselves his pupils; and the scientific position which so many of these men have won is evidence of the way in which he has fulfilled the highest function of a teacher, imparting to his hearers not only a great store of knowledge, but a just perception of the point where knowledge ends, and something of his own determination and energy in the acquisition of new scientific truth.

It is impossible to give anything like a detailed account of Prof. von Kölliker's scientific work, the results of which are embodied in some couple of hundred memoirs (written with apparently equal facility in any one of four languages) and in a series of text-books. All that can be attempted is an outline of its most important features.

The publication, in 1838, of Schwann's great work drew attention to a number of problems; and Kölliker was one of the first to realise that the complete justification of the cell-theory must be accomplished by a study of the whole history of animal tissues, from the fertilised egg onwards. The first results of this conviction are seen in his monograph of the development of Cephalopods (1844), and in a series of papers on the development of Amphibia (1846-1847). These memoirs are of great importance in the history of embryology, because they definitely bring the phenomena of the segmentation of fertilised ova into the category of normal cell divisions, and lay the foundation of the modern doctrine that an ovum is to be regarded as a single cell. Speaking in 1860 of his work on the Cephalopoda, Prof. von Kölliker points out, with justifiable pride, that he had already in 1844 asserted

> "Dass in der ganze Reihe der Entwicklung der thierischen Gewebe, ebensowie bei den Pflanzen, keine Zellenbildung ausserhalb der schon vorhandenen sich finde, vielmehr alle Erscheinungen als die ununterbrochene Folge von Veränderungen ursprünglich gleichbedeutender und alle von Einem ersten abstammender Elementarorgane aufzufassen seien"—

the process of derivation being always a cell-division comparable with the division of cells in a later embryo, or in the adult body (cf. *Entwicklungsgeschichte*, ed. 1861). But besides this important general proposition, the memoir contains a detailed account of Cephalopod development, so far as it could be studied by the methods available at the time, which is of great and permanent value to students of molluscan embryology. The papers on the development of Amphibia describe in outline the process by which the cells of cartilage and blood, the walls of blood-vessels and the elements of embryonic muscle are derived from blastomeres, and therefore have an important bearing on the fundamental problems of histogenesis.

A second series of early papers (1841-1847) was of great assistance, although in a different way, to the study of animal development. The acceptance of Caspar Wolff's doctrine of epigenesis, while it led to a right understanding of the structure of the ovum, was accompanied for a time by a curious belief concerning spermatozoa. After the discovery of these bodies in Leeuwenhoek's laboratory (1677) they were held by many supporters of the hypothesis of "evolution" to contain the whole preformed germ of the future animal, which unfolded and grew after entering the egg. This view never obtained universal acceptance, and it was abandoned by every one at the close of the eighteenth century, as Wolff's view of development became fashionable; but the belief which then grew up was further from the truth than that previously held, for it was maintained that spermatozoa were parasites of extraneous origin, which played no part whatever in the process of fertilisation. This belief was finally destroyed by the researches of Kölliker, who showed conclusively that spermatozoa arise from the tissues of the male gonad, and said in 1847: "Ich betrachte sie als befruchtende Princip und glaube, dass sie durch Berührung der Eier in denselben ein neues Leben erwecken"—thus leading the way directly to modern views. These papers again, besides establishing an important general proposition, contain statements of value on many points of detail, among which the descriptions of the large non-motile male elements of the higher Crustacea may be mentioned.

The two series of memoirs referred to contain perhaps the most fundamental results achieved before going to Würzburg in 1847; but they give no idea of the amount of work actually done before that date. In the field of pure histology must be mentioned the memoir on the Pacinian bodies, written in cojunction with Henle (1844); the important demonstration of the whole course of the connection between a medullated nerve fibre and a nerve cell (1845); a memoir on the spleen, and another on the synovial membranes (1847); also a preliminary account of the researches on the structure of smooth muscle, which were fully described later. Of more purely zoological interest are the papers on the hectocotylus of Cephalopods, in which the trematode hypothesis is shown to be untenable; the paper on the marginal bodies of Medusæ (1843), which contains the earliest recognition of the nature of the otocysts in these animals; the description of the remarkable *Rhodope Varanii* (1847), discovered by v. Kölliker; and two papers, written in conjunction with Löwe, on the presence of cellulose in the test of Tunicata (1846).

On going to Würzburg, Prof. v. Kölliker's activity was if anything increased. He almost immediately joined von Siebold in founding the *Zeitschrift für wissenschaftliche Zoologie*; and it is not the least of his claims to the gratitude of biologists that he has continued for half a century to edit this valuable journal. The first numbers contain a series of papers written by himself, of which the following are the most important.

The essay on *Actinophrys* recognises the rhizopod nature of this animal, and contains a remarkable discussion of the manner in which rhizopods generally ingest their food. The suggestion is clearly made that the contractile substance of *Actinophrys* and *Amœba* is identical in nature with that of *Hydra* and of the higher animals; so that this paper, and Ecker's paper on the contractile substance of *Hydra* which is printed immediately after it, mark an important step in the general conception of what is now called protoplasm.

The monograph of the *Gregarinidæ*, also in the first volume, clearly recognises the unicellular nature of an adult *Gregarina*, and in it the *pseudonavicellæ* are stated to represent stages in the life-history of the *Gregarina*. Many species of Gregarines are described.

[The description of *Dicyema* (1849) may be most conveniently referred to here, although it was not published in the *Zeitschr. f. w. Zoologie*.]

Of papers relating to vertebrate histology, published in the early numbers of the *Zeitschrift*, the most important are the memoirs on smooth muscle, and on the skin. In the first the result of the work already referred to is more fully described. This memoir contains a description of the cellular elements of smooth muscular tissue, and a detailed account of its occurrence in the vertebrate body, including a final demonstration of its presence in the walls of the blood-vessels, which was doubted by several anatomists at the time. In the second memoir, the development of the epidermis is described, and a full account of the development of sweat-glands, hairs, and sebaceous glands is also given.

A paper on nerve-cells, and a note upon the distinction between the two classes of cranial bones, according to their method of ossification, must also be mentioned.

The first published volume of the "Mikroskopische Anatomie," the first of the series of text-books which Prof. von Kölliker has produced, appeared in 1850. This volume was the second of the projected work, and contained a systematic account of the various organs, illustrated by a large series of original figures, many of which have been copied by subsequent writers continuously until the present day. Within two years this was followed by the celebrated "Handbuch der Gewebelehre des Menschen," translated into English, soon after its appearance, by Busk and Huxley, and again (from a subsequent edition) by Bowman.

These masterly works are remarkable not only for their complete treatment of adult histology, but for the way in which the development of each tissue is described, whenever such description is possible, as a means of elucidating its adult structure. The necessity for such a study of the whole history of a tissue, from the egg upwards, is emphatically dwelt upon in the introduction to the "Gewebelehre." Among points of interest in special sections must be mentioned the whole treatment of the derivatives of the ectoderm (other than the central nervous system), including the development of the sweat-glands, the sebaceous and the mammary glands, and a description of the structure, development and succession of hair, which seems, if an English reader may presume to judge, clearer in some respects than the description given in the *Zeitschr. f. w. Zoologie*. The relation between striped muscles and their tendons is described so as to confirm, by independent evidence, many of the statements of Bowman; and a special point of interest in the account of muscular tissues is the description of the branched muscle-plates of the heart and certain other organs, which had been described by Leeuwenhoek, although the description seems to have been forgotten until the rediscovery of the structures by Prof. Kölliker. The chapters on the bones and on the process of ossification describe the mode of addition to bone beneath the periosteum, and include a detailed description of the growth of bone, together with the ossification of membrane bones. These chapters, in which the results of Prof. von Kölliker's researches were shown to be in complete agreement with those conducted in this country by Sharpey, had an important influence upon scientific opinion. The formation of "membrane bones" had been asserted by Nesbitt in 1736, and since his time by Rathke, Jacobson, and others; but the researches of Sharpey in this country, and von Kölliker in Germany, gave the first intelligible account of the process from a histological point of view. The chapters dealing with the spleen, and with the organs of reproduction, must be mentioned; and the account of the ear is especially interesting, from the remarks upon the work of Corti, which had recently been carried out in Würzburg itself, and described in the third volume of the *Zeitschr. f. w. Zoologie*. It is characteristic of Prof. von Kölliker's scrupulous care that, although this work had been done so lately in his own University, he investigated the whole matter again for himself before writing the chapters dealing with it.

During the next ten years many important papers were published. In 1853 Kölliker paid a visit to Messina in the company of H. Müller; and after their arrival the two naturalists were joined by Gegenbaur. The visit has become celebrated among zoologists because of the investigations which were then begun. An account of the work done by each of the three naturalists is given in a joint paper (*Zeitschr. f. w. Zoologie*, Bd. iv.). Prof. Kölliker occupied himself chiefly with observations on the structure and development of hydrozoa; a sketch of his observations is given in the paper referred to, and his fuller quarto work on the Siphonophora was published in the following year, while a paper on the development of Pneumodermon, by Profs. Gegenbaur and Kölliker together, appeared in the *Zeitschr. f. w. Zoologie* for 1853.

Between this time and 1861 appeared a series of papers on the vertebrate notochord, in its relation to the adult vertebral column and to the skull. The investigations recorded in these papers constitute an important step in the detailed knowledge of the cranial notochord of the lower Fishes; while the description of the post-cephalic notochord leads to a classification of vertebral columns generally, based upon the degree to which the chordal sheath persists, and the share taken by this structure and by the "skeletogenous layer" of tissue outside it, in the formation of vertebral centra. The classification suggested was not accepted for many years; but it has lately been justified, and has formed the starting-point for important recent work. Of great value are the papers on the minute structure of the bony skeleton of adult fishes, published during the same period.

In 1861 the first edition of the "Entwicklungsgeschichte des Menschen u. d. höheren Thieren" was published. This edition is of interest not only from its scientific value, but because of its form. It is printed, after some revision, from the shorthand notes of a course of lectures delivered in Würzburg in 1860; and one can, therefore, gather from it some faint idea of the author's method and style of exposition. As usual, the book contains the result of several original investigations. Especially interesting are the lectures on the nature of meroblastic ova, and on segmentation of ova generally, and those relating to the development of the nervous system and the organs of special sense.

In the meantime the "Handbuch der Gewebelehre" had passed through three editions, and had been again translated into English. In 1863 the fourth edition appeared.

In 1864 Prof. v. Kölliker made his first statement of opinion upon questions raised by the publication of the "Origin of Species." While he accepted a doctrine of descent with modification as a statement of the way in which species had appeared upon the earth, he refused to admit that Natural Selection had been the agency by which the modification had been produced, and he argued against the assumption that "utility" in the Darwinian sense had determined the survival of varieties. He also urged the possibility that variations of considerable magnitude might suddenly appear and survive. In his subsequent writings he has maintained essentially the same position, postulating an *allgemeine Entwicklungsgesetz*, working independently of any utilitarian effect, which determines the evolution of living things. His conception of the process of evolution is, therefore, allied to that of Nägeli and his school rather than to that of Darwin himself.

From 1865–1875 appeared a series of papers dealing with the anatomy of Cœlenterates, and including the celebrated memoirs on the Alcyonaria (on *Renilla*, 1871; on the *Pennatulida*, 1872; on *Umbellula*, 1875). These papers, with their account of the remarkable dimorphism of the pennatulid zooids, and the mass of anatomical information they contain, are of fundamental importance to the student of the Alcyonaria. In 1879 the report on the *Pennatulida* collected during the voyage of H.M.S. *Challenger* was written.

A fifth edition of the "Gewebelehre" appeared in 1867.

Other work during these years deals with the development and resorption of bone, and with various points in the development of Vertebrates, especially of Mammals.

In 1876 the second edition of the "Entwicklungsgeschichte des Menschen u. d. höheren Thiere" was published. This edition is much larger than the first, and contains what Balfour, in his notice of the book calls "the most complete description which has yet been given of the early development of the Bird and Mammal" (*Journ. Anat. Physiol.*, 1876). Especially interesting are the account of the development of the Fowl during the first three days of incubation; the statements concerning the origin of the heart and the Wolffian bodies; and the whole account of the early development of the Rabbit. The great number of original figures shows how largely the whole work is based on personal observation.

The considerable series of embryological and other papers published since that time cannot here be noticed. The little space remaining must be given to a mention of the last edition of the "Handbuch der Gewebelehre," of which the first volume was published in 1889. This is, as the author declares in the preface, rather an altogether new treatise than a new edition of an old one; and as usual every page shows how largely it is based on Prof. von Kölliker's own observations, whether original or in confirmation of results obtained by others. The first volume deals with the simple tissues, with the skin and its derivatives, with bone and with muscle. The second volume, which deals with the nervous system, appeared in parts from 1893 onwards.

The advance in knowledge since the fifth edition of the "Gewebelehre" is nowhere so striking as in the case of the central nervous system. The extended study of degeneration following upon injury, and the histological methods introduced by Erlich, Golgi, and others, have led to a rapid increase in knowledge concerning the distribution of nerve fibres both within the central nervous system and outside its limits; while an altogether new conception of the anatomical relations of ganglion cells has been established. Prof. von Kölliker was one of the first to recognise the importance of Golgi's work; and after visiting him in Padua in 1887, he adopted the new method in a series of investigations, some of which are described in seven papers published between 1889 and 1891 (cf. especially *Zeitschr. f. w. Zoologie*, vols. xlix. and li.), while the results of others appear for the first time in the second volume of the "Gewebelehre." This volume, of nearly 900 closely-printed pages, illustrated by 840 figures, most of which are as usual original, attempts nothing less than an outline of the comparative histology of the central nervous system in Vertebrata generally. The value of this enormous work arises not only from the new statements of fact which it contains, but from the systematic treatment of the mass of detail, constituting almost a new science, by a man who knows every fact referred to from his own observation.

This is not the place in which to speak of the numerous and well-merited honours conferred upon Prof. von Kölliker by the Government of his own country and by scientific societies and academies in almost every land. It is hoped that the foregoing imperfect outline of his work may give some idea of his position as one of the founders of modern systematic histology, and of his valuable services to embryology and comparative anatomy. Those who are best able to judge the imperfections of this sketch will be best able to understand the magnitude of the attempted task.

W. F. R. WELDON.

NITRO-EXPLOSIVES.

Explosifs Nitrés. By J. Daniel. Pp. viii + 235. (Paris: Gauthier-Villars et Fils.)

BY far the greater portion of this book is a fairly literal translation of Mr. Sanford's work on nitro-explosives, published in 1894. It suffers therefore, in many respects, from the same defects, though in others it is a decided improvement. Like the original it gives, for example, a description of all the gelatinised nitroglycerine preparations before giving the manufacture of the various nitro-cottons used in gelatinising them, which is, in several respects, an inconvenient arrangement. Like Sanford's work, it describes the manufacture of nitroglycerine and nitrocellulose in greater detail than is necessary for the use of a general chemist, and yet insufficiently so to serve as a complete guide to the manufacturer. The description of nitroglycerine is, however, a marked improvement on the original, and does not, for example, leave the reader in doubt as to whether nitroglycerine should be regarded as a nitric ether or not. It is, therefore, all the more surprising to find that M. Daniel, like Mr. Sanford, has apparently failed to grasp the great importance, from a theoretical as well as a practical point of view, of the fundamental difference between a nitric ether, on the one hand, and a true nitro-compound on the other. The former, although, when pure, perfectly stable at ordinary temperatures, decompose readily at, comparatively speaking, low temperature, and are one and all unstable at ordinary temperature in the presence of even minute traces of strong mineral acids as well as in the presence of many organic acids. Hence, in order to ensure the stability of a powder containing a nitric ether, it is absolutely essential not only to exclude all free acids, but also all compounds likely to become acid. Hence ammonium salts, like nitrate of ammonium, for example, may be used with perfect safety in admixture with a nitro-compound, such as dinitrobenzole in the manufacture of bellite, roburite, securite, &c., whereas the presence of this salt would be fatal in an explosive containing a nitric ether such as guncotton or nitroglycerine.

The preparation of the various nitro-celluloses, soluble and insoluble, is given very fully—too fully for the general chemist; but the author, in following too closely his original, fails to point out that the question of solubility or non-solubility of nitro-cotton is, in great measure, at least, one of method of manufacture and not one of degree of nitration, and also depends, in a measure, on the temperature of the ether alcohol mixture. This is very remarkable, seeing that the Cordite trial, during the progress of which this question of soluble and insoluble guncotton was very fully discussed, is several times alluded to in the work. The statement, found in both works, that the sulphuric acid in the manufacture of guncotton does not take part in the reaction, is, at least, open to doubt. The manufacture of celluloid, to which eight pages are devoted, however interesting in itself, should scarcely occupy so much space in a work of only 271 pages devoted to nitro-explosives.

A very useful addition of M. Daniel consists in a description of the physiological effects of nitroglycerine and dinitrobenzole. The baneful effects of this latter compound on the health of the workpeople employed in the manufacture of explosives containing it, was first clearly established by a small Departmental Committee of the Home Office, and it is curious to find it taken up by a Frenchman and omitted from the work of an Englishman.

Most of the more commonly used explosives are shortly, but sufficiently described; but the mistakes found in the original unfortunately reappear in the translation. Thus roburite never was a mixture of ammonium nitrate and chlorodinitrobenzole, but one of the former salt with chlorinated dinitrobenzole containing, at most, 2 per cent. of chlorine, a very different thing. This original roburite is no longer manufactured in England. M. Daniel also, like Mr. Sanford, gives what may be called the ideal composition of dynamite (25 per cent. kieselguhr and 75 per cent. nitroglycerine) as the ordinary one, whereas, as a matter of fact, commercial dynamite practically never contains 75 per cent. nitroglycerine, and almost always contains mineral matters besides kieselguhr.

As a further interesting addition by the translator may be mentioned the statement regarding the curious difference in the behaviour of frozen gelatine dynamite and